Ceiling Fans Case Study

Photo: Michael David Rose

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OVERVIEW

Location: Santa Cruz, CA
Project Size: 40,000 ft^2
Construction Type: New Building
Completion Date: 2017
Building Type: University Campus
Climate Zone: 3C
Total Building Cost: $54 million

Owner: UC, Santa Cruz
Architect: EHDD
General Contractors: Swinerton Builders
Structural Engineer: Mar Structural Design
Mechanical Engineer: Taylor Engineering
Civil Engineer: GHD Engineering

Thoughtful design of a world-class research facility highlights the benefits of ceiling fans in naturally ventilated spaces in ensuring occupant thermal comfort in educational settings.

COASTAL BIOLOGY BUILDING

The Coastal Biology Building brings together faculty and staff to support research and teaching on ecology and evolutionary biology. The LEED Gold Certified building is set on a 97-acre site with easy access to wetlands and other important natural habitats for field-based learning. The University of California, Santa Cruz worked with EHDD to deliver world-class facilities for marine and ocean health research located near the Monterey Bay National Marine Sanctuary.

The two-story building is a state-of-the-art facility that includes a 125-seat classroom and two smaller classrooms, 20 primary research laboratories, a core seawater laboratory, seminar and meeting rooms, and 43 research offices. The HVAC systems for many spaces in the building, including the main lecture hall, function without compressive cooling. The integrated facade strategy uses electrochromic glazing, operable windows, and easy-to-operate ceiling fans to ensure above-average occupant comfort in warmer temperatures in summer. The success of this strategy is reflected in the building earning a perfect score in the LEED Indoor Environmental Quality category.

Energy Performance

In keeping with the sensitive nature of the site, the building was designed with a context-appropriate agricultural vernacular with an emphasis on low energy use. The whole building site energy use intensity (EUI) of just 105 kBtu/ft² is 50% less than the average EUI performance of 118 laboratory and college buildings in the 3C climate zone within a federal database of over 230,000 buildings. This places the building in the top 25% of that dataset in terms of energy performance (Figure 1). In addition, it exceeds the best-practice targets in ASHRAE's Standard 100-2015 Energy Efficiency in Existing Buildings. The use of efficient high-volume, low-speed ceiling fans helped to ensure that the cooling systems consume only 1% of predicted electricity energy of the building.

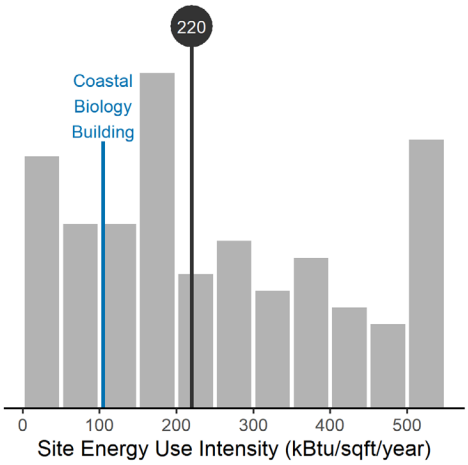

Figure 1. Energy use for both the main building and greenhouse is below 75% of laboratory and college buildings from the same climate zone in the Building Performance Database (BPD). The Site EUI of 105 is over 50% less than the mean EUI of 220.

Thermal Comfort

From the outset, Taylor Engineering wanted to pursue low-energy options to cool the mixed-use building. The cool coastal climate of the campus allowed them to design the HVAC system for the seminar space using an efficient single-zone air handler without a cooling coil. The seminar room has a ductless HVAC design, made possible by the use of ceiling fans to mix the air throughout the room and uniformly cool the occupants. Survey results show occupants' thermal satisfaction is well above that of comparable buildings in the CBE database (Figure 2). Figure 3 shows the mean score on the seven-point satisfaction scale was +0.8, well above the thermal comfort benchmark of +0.2 in the 112 classrooms and laboratories in the CBE database, placing it in the top 15% of buildings in that dataset.

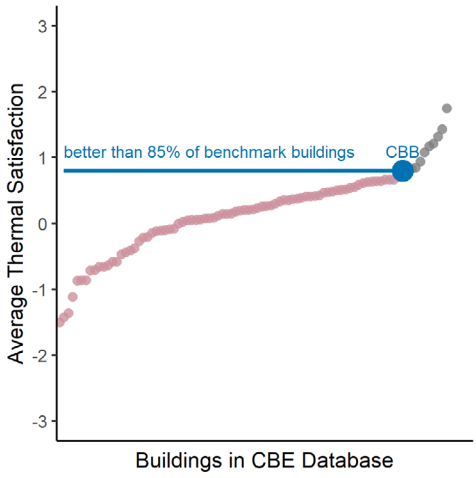

Figure 2. Satisfaction with the thermal environment at CBB is higher than 85% of classroom and laboratory buildings in the CBE Occupant Survey database.

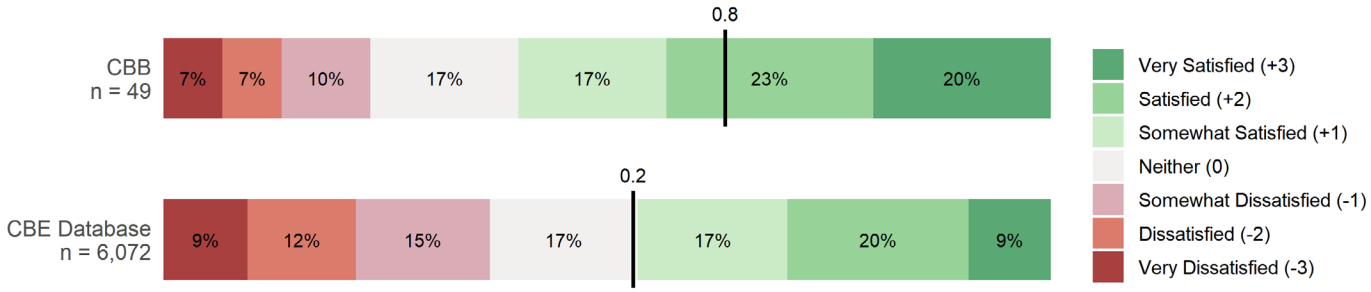

Figure 3. 60% of occupants in the Coastal Biology Building (CBB) rated their indoor temperature as satisfactory. The mean thermal satisfaction vote of +0.8 places it in the top 15% of classrooms and laboratories for thermal comfort in the CBE Occupant Survey database.

This case study is part of a project focused on energy and occupant factors within the larger study of Integrating Smart Ceiling Fans and Communicating Thermostats to Provide Energy-Efficient Comfort. It is being led by Paul Raftery at UC Berkeley Center for the Built Environment (CBE) and funded by the California Energy Commission (EPIC Project 16-013).